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D. A. Calahan

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Algorithm development. Implementation of a 3-D Navier-Stokes implicit research code fro AFFDL was initiated. This required the parallel solution of block-tridiagonal systems and so was more challenging than the above explicit code. This is being continued in a new AFOSR grant. Connection Machine experiments. To keep abreast of SIMD architecture performance, a series of Fortran and C kerrels were studied on the Argonne Laboratory CM-2 during the summer of 1989. It was concluded that the available Fortran 8X implementation on the CM-2 was too inefficient to warrant continued study at that time. Keyworks: Programmer; Languages, Computer programming computer orchitering.

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MASSIVELY-PARALLEL COMPUTATIONAL FLUID DYNAMICS

D. A. Calahan

Principal Investigator

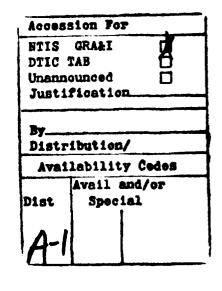
Laboratory for Scientific Computation

Department of Electrical Engineering & Computer Science

Ann Arbor, MI

University of Michigan

October 30, 1989





I. Progress Report

Goal

The research is intended to develop methodologies for specifying major machine design parameters for distributed parallel architectures useful in CFD. The effort has two major components.

- (1) Gain algorithm experience in conversion of a suite of Air Force production and research CFD codes to a general format applicable to a variety of such commercial architectures.
- (2) Relate critical code execution timing features to the machine parameters.

Progress (5/88-9/88)

- (1) Algorithm development [2]. A full 3-D Navier-Stokes explicit production code from AFFDL was implemented on a 1024-node scalar NCUBE hypercube at SANDIA (Albuquerque).
- (2) <u>Distributed-memory architectures for CFD</u> [1][3]. Timing models of this code were developed in terms of four critical design specifications MFLOP execution rate, message startup and transfer times, and local memory size. These models were intended to permit a graphical specification of hardware tradeoffs to achieve given levels of parallelization efficiency.

Progress (10/88-9/89)

- (1) Algorithm development. Implementation of a 3-D Navier-Stokes implicit research code from AFFDL was initiated. This required the parallel solution of block-tridiagonal systems and so was more challenging than the above explicit code. This is being continued in a new AFOSR grant.
- (2) <u>Connection Machine experiments</u>. To keep abreast of SIMD architecture performance, a series of Fortran and C kernels were studied on the Argonne Laboratory CM-2 during the summer of 1989. It was concluded that the available Fortran 8X implementation on the CM-2 was too inefficient to warrant continued study at that time.

II. Coupling Activities

Air Force Flight Dynamics Laboratory

Several of the codes under study to illustrate the architectural modeling process were obtained from Dr. Joseph Shang, director of the Computational Aerodynamics Group at AFFDL. Five visits were made to his laboratory to plan the coordination of our research efforts. A four-processor NCUBE massively-parallel algorithm preparation workstation was loaned to his group to assist in these joint efforts.

Near the end of the grant period, it was decided during a visit that a moderately-parallel message-passing network of workstations would be of immediate interest to Dr. Shang's group; further, it appeared that the above-mentioned parallelized CFD code would be directly applicable to such an architecture. Work is continuing on this research under new AFOSR-sponsored funding.

III. Publications

- [1] Wu, E.S., D.A. Calahan, and R.A. Wesley, "Performance Analysis and Projections for a Massively-Parallel Navier-Stokes Implementation," Proc. Fourth Conference on Hypercube Concurrent Computers and Applications, Monterey, CA, March, 1989.
- [2] Wesley, R.A., E.S. Wu, and D.A. Calahan, "A Massively-Parallel Navier-Stokes Implementation," Proc. AIAA Computational Fluid Dynamics Conference, Buffalo, NY, June, 1989.
- [3] Calahan, D.A., "Specification of a Fluids MIMD Distributed-Memory Architecture," Proc. Parallel CFD Conference, Los Angeles, CA, May, 1989.